

afterwards found that the metal could be obtained from the ash by furnace assay—fusion with pure lead carbonate, sodium carbonate, and a little cream of tartar, and cupellation of the lead button produced; and a comparative experiment was made, with negative result, using larger quantities of the same reagents, but omitting the volcanic ash.

It was ascertained that silver could be extracted from the ash by boiling it with a solution of ammonia, or of potassium cyanide, or of sodium thiosulphate, but the metal was not dissolved out in appreciable amount on boiling with nitric acid. Hence, as seems most probable, it was present in the ash as silver chloride. The fact of its being found in the solution in hydrochloric acid of the mass resulting from fusion with the alkaline carbonates, is of course easily explained by the solvent action upon silver chloride of the chlorides of sodium and potassium, and (when such minute quantities are concerned) of hydrochloric acid itself.

The discovery of silver in the ash in question adds for the first time this metal to the list of elementary substances observed in the materials ejected from volcanoes, and the addition derives some special interest from the fact of the ash having come from the greatest of the volcanic vents of the great argentiferous chain of the Andes.

Lead, which was found by Señor Santos himself, when a student here in 1879, in a specimen of ash from the eruption of Cotopaxi of August 23rd, 1878,* was sought for in the ash now reported upon, but neither it nor any other heavy metal beside silver was detectable.

Several concordant experiments proved that the silver was present to the extent of about 1 part in 83,600 of the ash, or about two-fifths of a Troy ounce per ton of 2240 pounds. Small as is this proportion, it must represent a very large quantity of silver ejected during the eruption, in view of the vast masses of volcanic ash which must have been spread over such an area as is indicated by the fall at so distant a point as Bahía de Caraguez.

II. "Preliminary Note on the Continuity of the Liquid and Gaseous States of Matter." By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc. Communicated by Prof. G. G. STOKES, D.C.L., P.R.S. Received November 30, 1886.

For several years past we have been engaged in an examination of the behaviour of liquids and gases through wide ranges of temperature and pressure. The results of our experiments with ethyl alcohol have recently been published in the 'Philosophical Transactions;' those with acetic acid in the 'Journal (Transactions) of the Chemical Society'; and the Royal Society have in their hands a

* 'Chem. News,' Oct. 17, 1879 (vol. 40, p. 186).

similar investigation on ether. We have also finished a study of the thermal properties of methyl alcohol.

In consequence of a recent publication by Wroblewski, of which we have seen only the abstract ('Deutsch. Chem. Ges. Berichte,' 1886 (Referate), p. 728), we deem it advisable to communicate a short notice of an investigation in which we are at present engaged.

We find that with the above-mentioned substances, acetic acid excepted, whether they are in the liquid or gaseous state, provided volume be kept constant, a simple relation holds between pressure and temperature. It is

$$p = bT - a.$$

This is evidently a simple modification of Boyle's and Gay-Lussac's laws; for at low pressures, where volume is large, the term a approaches and finally equals zero, while b diminishes and finally becomes equal to the value of c , calculated from the ordinary equation,

$$p = \frac{cT}{v}.$$

We have as yet only had time to apply this formula with ethyl ether to the liquid state; and as we are not yet quite certain whether the relation holds when 1 gram of ether occupies volumes between 4 and 20 c.c., we are at present engaged in measurements of volumes and pressures at temperatures between 220° and 280°. Assuming the above relation to be true (and it is at all events a close approximation to truth), it is possible to calculate those portions of isothermals included within the liquid-gas area, and represented in Andrews' diagram by horizontal straight lines. We have calculated a few of these isothermals for ether, and find that the areas above and below the horizontal lines (see woodcut) are equal, when measured by a planimeter.

Reserving a full discussion of the subject until the completion of our experiments, we would here point out the similarity between the equation $p = bT - a$, and those proposed by Clausius and by van der Waals to represent these relations. Clausius's formula is

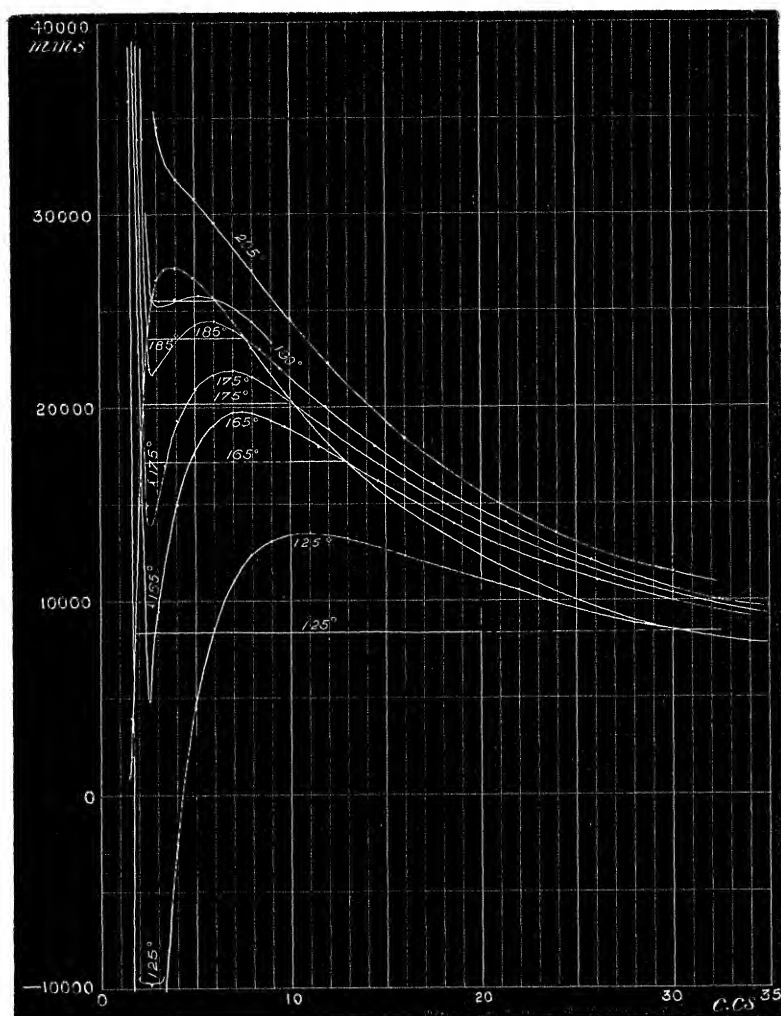
$$p = \frac{RT}{v - \alpha} - \frac{c}{T(v + \beta)^2},$$

and van der Waals'

$$p = \frac{RT}{v - b} - \frac{a}{v^2}.$$

In these formulæ Clausius's α and c are equivalent to van der Waals' b and a respectively, but R has a different signification.

We find that a somewhat similar formula agrees better with experiment than either of the above; it is



$$p = \frac{RT}{v-b} - \frac{a}{T v^2},$$

where R , b , and a have the same meaning as in van der Waals' formula. This formula expresses the results of experiments with great accuracy, where the volume of 1 gram of ether occupies not less than 25 c.c.; but at smaller volumes it ceases to represent the facts.

It is to be noticed that both Clausius's equation and ours introduce

T into the denominator of the second term; they evidently differ from our first equation $p = bT - a$, in which a is independent of temperature.

We shall soon be in a position to communicate the results of this investigation, giving full data.

[January 18th, 1887.—We have alluded to Clausius's formula, $p = \frac{RT}{v-\alpha} - \frac{c}{T(v+\beta)^2}$; his latest published formula is, however, $p = \frac{RT}{v-\alpha} - \frac{c}{\Theta(v+\beta)^2}$, where $\Theta = aT^n - b$. As the second term is here also a function of temperature, it is evident that his last equation is also not in accordance with the simple relation $p = bT - a$].

III. "Note on *Lepidodendron Harcourtii* and *L. fuliginosum* (Will.)." By W. C. WILLIAMSON, LL.D., F.R.S., Professor of Botany in the Owens College and in the Victoria University. Received November 27, 1886.

In March, 1832, the late Mr. Witham read to the Natural History Society of Newcastle-upon-Tyne the first public notice of the classic specimen of *Lepidodendron* known as *Lepidodendron Harcourtii*. Still later (1833) he published further figures and descriptions of the same specimen in his work on 'The Internal Structure of Fossil Vegetables.' Additional figures and descriptions of the same object appeared in the second volume of Lindley and Hutton's 'Fossil Flora,' and in Brongniart's 'Végétaux Fossiles.' But notwithstanding all these publications the exact plant to which they referred has long been doubtful. I hoped to have found either the original specimen in the museum of the Yorkshire Philosophical Society or the sections described by Lindley and Hutton in that of the Newcastle Society; but, though carefully sought for, I long failed to discover either one or the other.

In 1871, I laid before the Royal Society my memoir, Part II, "On the Organisation of the Fossil Plants of the Coal-measures," in which I figured (Plate 25, fig. 12), a plant that seemed to me to be identical with *L. Harcourtii*; and in Part XI (1880) of the same series of memoirs, I gave further representations of the same plant (Plate 51, fig. 10; Plate 49, fig. 11). Since the publication of the latter memoir I have obtained a fine series of specimens, which appeared to me to approach still more closely to the various representations of *Lepidodendron Harcourtii*, referred to above, and which inclined me to think that I had hitherto included two species under a common name. The two forms unmistakably belong to a common type, to which I

